SUSTAINABLE MANAGEMENT OF BIODIVERSITY (SMB), SOUTH CAUCASUS

GUIDELINES FOR HARVESTING, PROCESSING, STORAGE AND QUALITY CONTROL OF FOREST SEEDS

RA Ministry of Agriculture

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:
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Seeds are delicate living organisms that should retain their viability and health during all seed-handling operations. Seed operations such as harvesting, extraction, cleaning, transporting, and storage can substantially affect their germination quality and health. Careful and constructive planning and monitoring of the state of the harvested seed material during each of these steps will result in seed viability and longevity.

1. HARVESTING

The storage of seeds and fruits depends on the degree of their maturity and the timing of harvesting. A high sowing quality can be endured only with mature seeds that have been harvested in time and have been properly processed. Harvesting should be conducted right after the seeds reach maturity on the plant and before they become over-ripe or acquire a disease. Late-harvested seeds, fruits, and cones over-ripen on the mother plant and become underqualified due to the loss of sowing qualities (germination capacity, germination vigour, viability, etc.). As a rule, seeds and cones are harvested when the embryo is ready and germinable: seeds become rigid and elastic, whereas fruits and cones assume the colour peculiar to the given species. The maturity periods of seeds, which determine the planning and execution of harvesting, are variable and depend on the geographical origin of the plant, climatic conditions, and other factors.

Image 1. Seed Collection with a Net

Image 2. Mature and Immature Seeds

Image 3. Seed Collection

2. MAINTAINING VIABILITY

Most fruits and cones are picked while the seeds are not yet sufficiently dry for storage. Typically, the moisture content of mature seeds lies above 15%. After extraction and drying the seed reaches a lower moisture content of about 8%. The ability of the seed to withstand adverse conditions varies greatly among species as well as depending on the degree of seed maturity and its moisture content. Generally, a seed with higher moisture content is easier damaged by high temperature, fungi and insects.

Fruits and cones should be kept in dry and cool conditions during necessary temporary storage and transportation. The period between collection and extraction should be minimized, and infestation from the surrounding environment should be carefully prevented.

Image 4.

The microclimate inside the container is of paramount importance during temporary storage and transportation. The container should be sufficiently strong yet allow good ventilation to prevent the rise in relative humidity or temperature. Loosely woven hessian sacks are commonly used. Open mesh baskets are an acceptable alternative, made of locally available materials such as steel wire, young willow branches or local rattan. Cotton bags can be used for smaller seeds. Only new or at least very clean bags are allowed to avoid mould and fungal spores, which used bags usually carry. Plastic bags can be used only for storing and transporting dry seeds (see image 4).

The use of insecticidal or fungicidal dust may be necessary under some circumstances if there is a risk of severe damage. Large care is needed in treating fresh and relatively moist seed to avoid damage to the seed by the chemica itself.

The choice and use of insecticides and fungicides should be limited so that the seed can be handled manually in subsequent processes. Under normal conditions, good hygiene practices such as using new bags, picking fruit from the trees (not from the ground), keeping low levels of temperature and humidity are sufficient to prevent the problems.

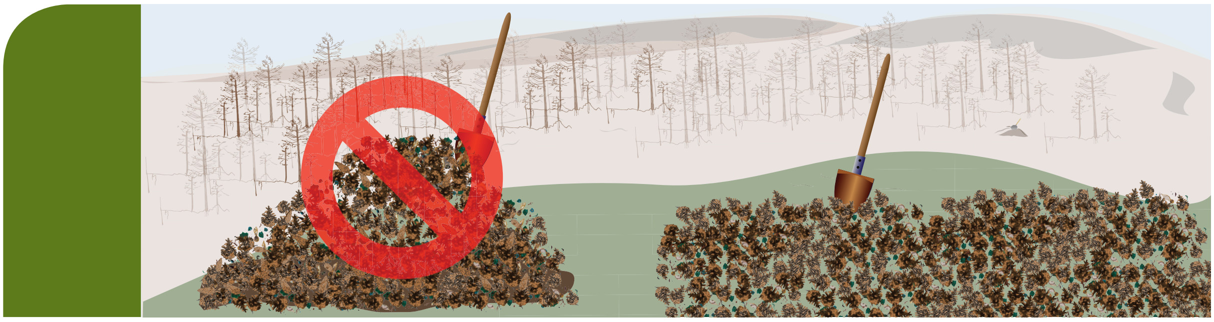

Image 5. The crop should be kept in a thin layer and turned daily with a wooden lance.

Special attention should be given to fruit and cones stored in larger amounts. The surface layers of the bulk may be dry while the temperature and humidity may be rising inside as an effect of respiration. Therefore, the crop should be kept in a thin layer and turned daily with a wooden lance until it is dry to the lowest level of respiration and the fruits no longer become warm in piles or sacks. The probability of mould occurrence largely decreases when moisture content in piles or sacks is kept at about 15%. Sacks should only be partly filled. Sacks with cones should be half filled as cones expand when they dry and their scales open.

Care should be taken not to mash pulpy fruit before extraction as this would inevitably result in fermentation Fruits and cones should not lie on the ground. Most infection in seed lots results from contact with soil-borne organisms on the forest floor or at the extraction site.

3. MAINTAINING THE SEED LOT IDENTITY

A stored seed lot without identity would be useless. It is necessary to develop a standardized, fail-proof identification system to maintain the identity of seed lots, especially during temporary storage, transportation and extraction, where the seed lot often changes custody. Identification of a seed lot comprises all the information related to it, i.e. the species name, weight and quantity, harvest location, collection date, collector's name, number of containers available, destination, reference to any accompanying papers, future seed testing date, etc. In addition to this, the seed lot and the harvest location/source should be given identification numbers.

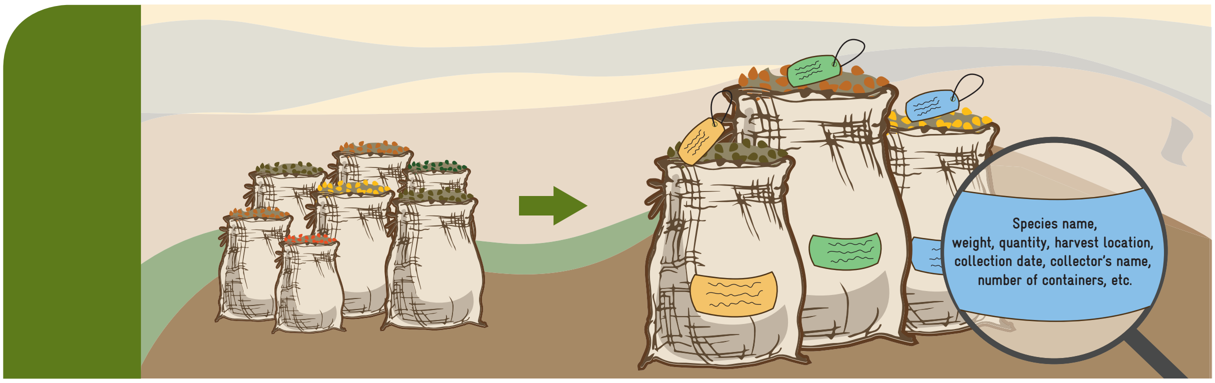

Image 6. A Seed Sack with Two Labels

As seeds are harvested, each seed container or sack must have two labels ready for use. One label should be put inside the container immediately after filling it with seeds, and the other one should be attached to the outside. Each label should contain all identification information mentioned above. Waterproof labels and pens must be used. If the fruits or cones are transported from the collection site directly to the end user, all information and certificates should be sent in advance and/or accompany the consignment in transit.

It is necessary to keep seed lots separate during all stages of production to avoid any intermixing of seeds. Small bags sewn of nylon mosquito nets are ideal containers for smaller seed lots. They allow good ventilation, and drying of seeds can be carried out without removal of seeds from the bag. When transporting seeds in large quantities in an open state, the vehicle should be carefully cleaned before each loading. For temporary storage of fruit or cones in open large quantities, the storage area should also be cleaned.

4. IMPORTANT STEPS OF SEED PROCESSING

Harvested seeds need to undergo processing, which is aimed at obtaining clean and high-quality seeds ready for storage, transportation, and sowing. Important steps of processing include the following:

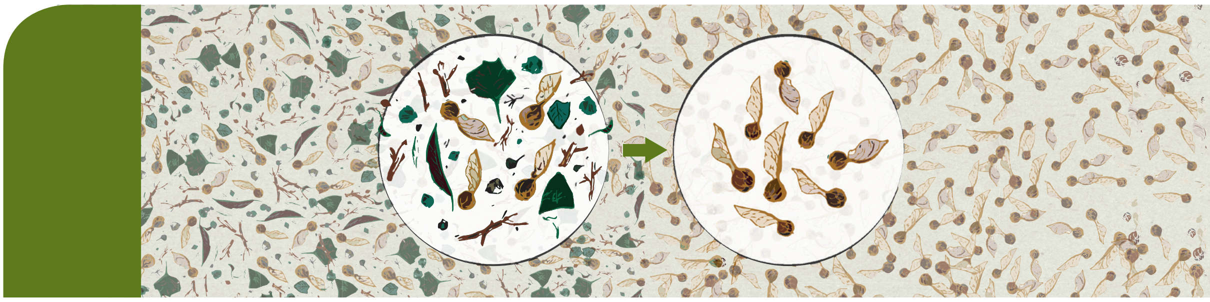

Image 7. Cleaning Seeds

Cleaning seeds of leaves, debris, broken seeds, empty fruit, twigs, fruit pulps, etc. in order to produce a seed lot with an optimal viability and longevity; these extraneous components may carry disease/infection;

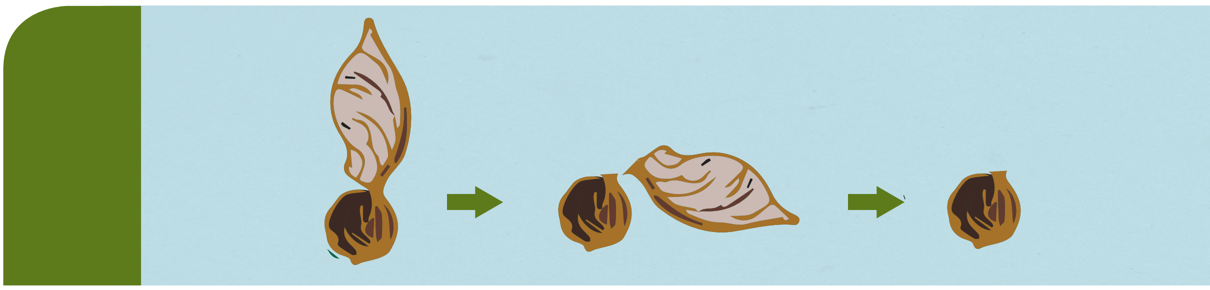

Image 8. Dewinging

Dewinging, i.e., removing from seeds such external appendages as spines, wings, hairs to make seed handling easier and more convenient. After dewinging another cleaning procedure might or might not be necessary depending on the cleanness of the seed lot;

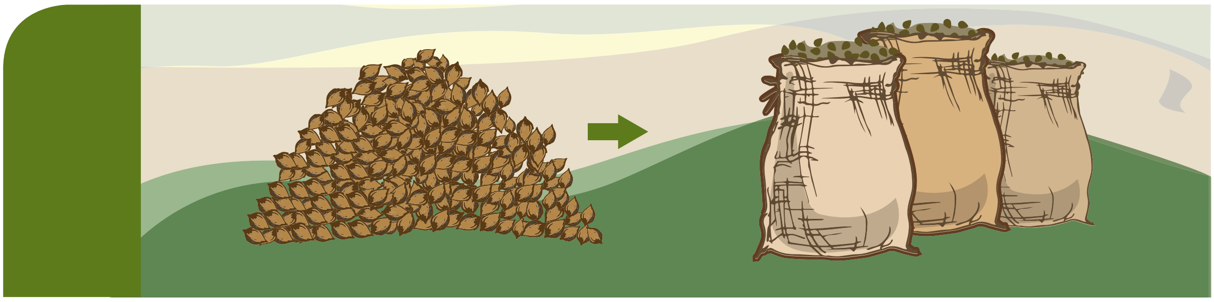

Image 9. Reducing Sizes of Seed Lots

Reducing sizes of seed lots in order to be able to provide optimal storage conditions;

Producing a homogeneous seed lot in order to be able to calculate the sowing density and produce an optimal seed bed;

Precuring of fruits, i.e., storage and slow drying of fruits that are not sufficiently ripe yet for seed extraction;

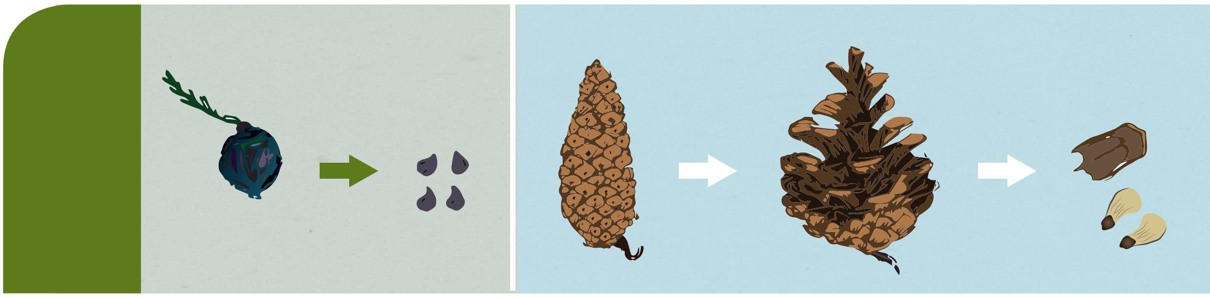

Image 10. Extracting Seeds

Extracting seeds out of the fruit and cones for storing and sowing;

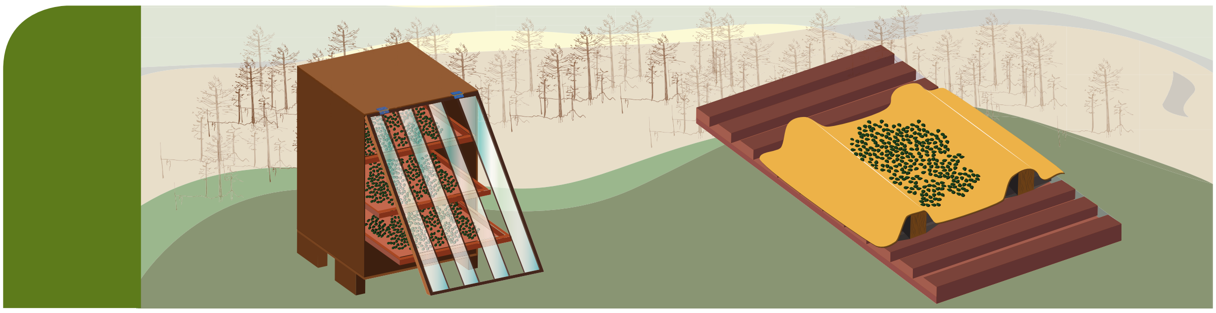

Image 11. Drying of Seeds

Drying of seeds to low moisture content before storage to increase longevity.

It must be noted, however, that different types of seed lots require different sequence of processing steps. *Table 1* below presents a simplified overview of processing sequences for different groups of cones and fruit. Some of the operations can be carried out manually without special equipment; but in case of processing of large batches of seeds a special extractory must be established with storage space, drying facility, refrigerated rooms, machines and other necessary equipment.

5. PLANNING OF SEED PROCESSING

For planning of seed processing the following information should be collected: the anticipated harvesting time-frame and periodicity (years between good crops while taking into consideration the increased storage demands), time of maximum temporary storage, type of the extraction procedure, amount of seeds (kg) needed per year, amount of seeds (kg) extracted from one kg of fruit. Some of these figures can be determined in collaboration with seed users as well as the teams responsible for seed collection.

Image 12. Seed Storage

TABLE 1: SEED PROCESSING PLAN

	Cones	Dry fruit	Pulpy fruits
Harvesting	Picking	Picking/collecting	Picking/collecting
Temporary storage	Precuring	Precuring	
Preparation for extraction	Precleaning	Precleaning	Precleaning
Extraction	Drying in the sun or in a kiln	Drying/threshing	Soaking
	Shaking or tumbling	Tumbling/separation	Maceration
			Washing
	Dewinging (wet or dry)	Dry dewinging	Drying, depulping, dehusking
Extra Cleaning/grading screening/sorting/ blowing/ floatation/friction/etc.	Cleaning, upgrading	Cleaning, upgrading	
Testing	Moisture content	Moisture content	
Final adjustment of moisture content	Drying	Drying	
Testing	Germination, purity, etc.	Germination, purity, etc.	
Storage and distribution	Dry/cold	Dry/cold	

6. SEED STORAGE

SEED BEHAVIOUR IN STORAGE: The key aim of seed storage is keeping seeds dormant before sowing without losing their germination capacity. The sowing quality of seeds can change depending upon storage duration and conditions. Long storage and unfavourable conditions may decrease the viability of seeds due to seed aging. According to the maintenance of their germination capacity, seeds are divided into three groups.

- Seeds that maintain their germination capacity for 3 years (microbiotic);
- Seeds that maintain their germination capacity for 3-15 years (mesobiotic)
- Seeds that maintain their germination capacity for 15 years and even longer, up to 100 years (macrobiotic)

Seed lots should be sown before the germination percentage drops below 80-60%. Generally, seed lots are discarded once the germination percentage falls below 50%. The seed survival duration is different for different species and also depends on the actual condition of the seeds as well as the external factors; among those, seed moisture, storage room temperature, and the presence of diseases and pests are considered most important.

TEMPERATURE: Temperature rise during storage is considered a violation of storage regime. A mass of seeds is a bad energy transmitter, and temperature rise as a result of respiration occurs in layers or focal points within the bulk. To avoid this, seeds should be aerated and the room should be ventilated. The best temperature for storing dry seeds is 4-10°C, and for longer term storage, 0-5°C. The relative humidity should be in the range of 50-70%.

MOISTURE: All seeds are divided into three groups depending on their optimal storage moisture requirements.

- Seeds, which have a considerably lower level of storage moisture (4-6%) than their own moisture in a dry state (pine, fir, juniper, larch)
- Seeds with a storage moisture (6-8%) a little lower than or equal to their own moisture (ash, maple, elm, hornbeam, thuja, apple, rowan and other)
- Seeds with a storage moisture much higher than their own moisture level in dry state (oak, beech, horse chesnut, walnut, chestnut and other): The storage temperature of these seeds is 0-5°C in stable moist conditions.

  All seeds except the second group should be dried for long-term storage right after harvesting.

7. STORAGE DURATIONS

The storage lengths of seeds are different and require corresponding storage conditions.

LESS THAN ONE YEAR: Seeds are stored for less than one year when both seed production and forestation are regular annual events, when local collections are undertaken by a nursery for its own use, when the species in question has poor storability or when the available storage facilities are so poor that the seeds are expected to lose their germination capacity within one year. Under these conditions the seeds are sown directly after processing or kept in storage until the first-coming sowing date. Seeds should be stored at moisture content below 8% at the lowest possible temperature. Under normal conditions this would be in the shade in a cool building or in a room with air conditioning if cold storage space is not available.

1-5 YEARS OR MORE: Seeds can be stored for 1-5 years when the species is storable, when it has irregular fruiting (periodicity), when available storage spaces are so good that it is economically feasible to undertake collections only in years with good crop. These conditions make it possible to concentrate on collecting fewer species every year and not be so dependent on anticipated seed demand and crop size. Storage of tree seeds for more than one year is usually carried out in a storehouse or in a seed bank. Here the amount of seed lots can reach several tonnes. Therefore, it is not possible to provide optimal storage conditions in all cases. Usually, these seeds should be stored in cold storage at about 2-4°C temperature and 6-8% humidity.

LONG TERM STORAGE: Seed samples are stored for future use, as is the case for gene resource conservation. The seed will be kept at optimal conditions (1-8% moisture content). As normal freezing equipment is the easiest accessible appliance (either domestic freezers or a conventional freezing storage), -18° C can normally be used. Because long-term storage is quite expensive, it can only be used for smaller seed lots.

TABLE 2: THE DESCRIPTION OF SEEDS OF A NUMBER OF FOREST SPECIES

N	Species	Time period		Sowing		Weigh of 1000 seeds	Viability%	Period of storage/ year	Pre-sowing treatment
		Maturity	Harvesting	Autumn	Spring				
1	2	3	4	5	6	7	8	9	10
1.	Juniperus oblonga	10-11	10-12	Starting from the 9th month of the 2nd year	early spring	8-10	30-40	4	Strat. 150-200 days
2.	Juniperus sabina	11-12	10-12	Starting from the 9th month of the 2nd year	early spring	8-9	30-40	4	Strat. 150-200 days
3.	Juniperus polycarpos	11-12	10-12	Starting from the 9th month of the 2nd year	early spring	5-8	20-30	4	Strat. 180-210 days
4.	Juniperus depressa	10-11	10-12	10	early spring	6-8	30-40	4	Strat. 150-180 days
5.	Juniperus foetidissima	11-12	11-12	Starting from the 9th month of the 2nd year	early spring	115-120	5-10	3	Strat. 120-150 days
6.	Quercus araxina	9-10	9-10	10-11	early spring	2-2.5 kg	70-80	0.5	_
7.	Quercus iberica	9-10	9-10	10-11	early spring	2.5-3 kg	80-90	0.5	_
8.	Quercus macranthera	9-10	9-10	10-11	early spring	2.5-3 kg	80-90	0.5	_
9.	Fagus orientalis	9-10	9-10	Starting from month 11	early spring	0.2-0.4 kg	70-80	0.5	_
10.	Acer ibericum	8-9	8-9	late spring	early spring	30-40	20-30	1	Strat. 30-40 days
11.	Acer campestre	9-10	9-10	Starting from month10	early spring	50-70	70-75	1	Strat. 140-160 days
12.	Acer trautvetteri	9-10	9-11	Starting from month10	early spring	50-60	80-90	2	Strat. 120-150 days
13.	Fraxinus excelsior	9-10	9-12	Starting from month10	early spring	70-90	70-80	2	Strat. 30-40 days
14.	Fraxinus oxycarpa	9-10	9-12	Starting from month10	early spring	50-70	70-80	2	Strat. 120-150 days
15.	Carpinus caucasica	9-10	10-12	Starting from month10	early spring	30-40	60-80	1	Strat. 90-120 days
16.	Carpinus orientalis	9-10	9-12	Starting from month10	early spring	20-30	60-80	1	Strat. 90-120 days
17.	Pinus pallasiana	11-12	11-12	_	early spring	22-27	90-100	4-5	_
18.	Pinus silvestris	11-12	11-12	_	early spring	6-8	75-90	5	_
19.	Pinus sosnowskyi	11-12	11-12	10-11	early spring	9-11	80-90	5	ww_
20.	Platanus orientalis	10-11	11-12	late autumn	early spring	4-6	30-40	2	moisten
21.	Platanus acerifelia	8-9	8-9	late autumn	early spring	15-20	60-70	3	moisten

8. SEED QUALITY

There are different criteria to assess seed quality. Some important criteria are presented below.

PURITY: purity is the percentage of pure seeds in a seed lot. Thus, to determine the purity the working sample is separated into pure seed, other seed and inert matter. The percentage of pure seed is calculated as follows: purity % = weight of pure seed fraction ÷ total weight of working sample x 100.

SEED WEIGHT: the purpose of the test is to determine the weight of 1000 seeds. ISTA (International Seed Testing Association, 2013) prescribes counting 8 random batches of 1000 pure seeds. The 1000 seed weight = the sum of the weights of the 8 individual replicates x 1.25.

MOISTURE CONTENT: the moisture content and the temperature are crucial factors during seed storage and handling. The moisture content could be determined as follows: Measure the fresh weight of 10 g of seeds, dry the sample in an oven in 103° C for 16 hours, measure the dry weight. Moisture content = dry weight ÷ fresh weight x 100.

GERMINATION PERCENTAGE: the main aim of the germination test is to establish the maximum number of seeds, which can germinate under optimal conditions of light, moisture and temperature. Germination test also allows determining how many seeds need to be seeded in each cell of a growing tray to avoid empty cells. According to ISTA rules, germination is tested on the pure seed fraction. Normally a test consists of 4 replicates of 100 seeds at random from the pure seed. The seeds are uniformly spread on a moist substrate. The samples should be kept in conditions of 20° C day/night and light for 16 hours per day. Germinated seeds are counted after 7 days, after 14 days and finally after 21 days. A germinated seed should be 4 times its seed length. The germination percent = the sum of germination of the 4 replicates ÷ 4. The figures shown after 7 days can be used as a measurement for the germination energy. The higher the figures after 7th day, the higher the germination energy and the viability of the seed lot.

VIABILITY: Viability is one of the important quality indicators of seeds, which is used for the description of the sowing quality of those seeds, which have a long period of germination. To determine the viability of seeds, a certain number of seeds (300-400) is pre-moistened in water until the seeds are fully swelled. Thereafter, the embryo is carefully removed from the seeds by a razor or a sharp knife, and is put into an iodine solution (5%) for 1-2 days. The living cells of the seed embryo turn into violet, whereas the non-viable, dead cells remain colorless. Viability is determined by the ratio (in percentage) of the overall number of living (colored) seeds to the overall number of seeds used for analysis.

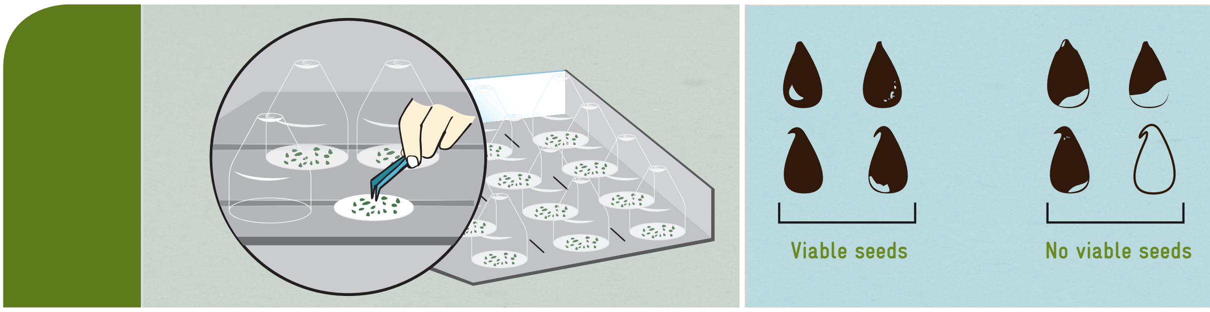

Image 13. Germination Table

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Published by "Time to Print" Salon of Operative Printing, Yerevan, RA

February, 2015